UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte LAWRENCE N. CRANE, MARK M. KONARSKI,
ERIN K. YAEGER, AFRANIO TORRES-FILHO,
J. PAUL KRUG and REBECCA TISHKOFT

Appeal No. 2005-1274
Application No. 09/985,728

ON BRIEF

Before KRASS, GROSS and SAADAT, Administrative Patent Judges.

KRASS, Administrative Patent Judge.

DECISION ON APPEAL

This is a decision on appeal from the final rejection of claims 1-56, 60, and 61.[1]

The invention is directed to joining a circuit chip to a carrier substrate, such as a circuit board. It was conventional to provide an underfill material between the surfaces

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[1]We note that the claims in the Brief Appendix are not consistent with the most recent amendment to the claims as per the amendment filed on July 28, 2003, e.g., paragraph c) of claim 1 and paragraphs c) and d) of claim 25 differ from the amendment. Upon return of the application to the examiner, it is incumbent upon the examiner to review the claims in the Appendix thoroughly and if necessary have the discrepancy in the Brief Appendix corrected.

of the circuit chip and the carrier substrate, with the underfill material assisting in adhering the chip to the substrate. The underfill was applied through capillary action after the chip was bonded to the substrate. The instant invention provides the circuit chip as an independent structure, having electrical contacts in the form of solder bumps on the surface of the chip. A fluxing agent is disposed on the solder bumps and a distinct and separate curable thermosetting underfill material is provided directly on the chip for mating the chip with a separate carrier substrate. The appropriate underfill material is provided between the chip and the substrate upon mating and solder reflow.

Representative independent claim 1 is reproduced as follows:[2]

> 1. An integrated circuit chip electrically interconnectable with a carrier substrate comprising:
>
> a) a chip die having electrical contacts arranged on a surface thereof for providing electrical interconnection with electronic circuitry on a surface of the carrier substrate, said electrical contacts being flowable upon heating;
>
> b) a fluxing agent disposed on a surface of said electrical contacts at a location capable of providing effective fluxing activity to said electrical contacts of said chip die an said electronic circuitry of the carrier substrate when said chip die is mated with the canier substrate; and
>
> c) a curable thermosetting underfill composition dispensed in a flowable form over said chip die about said electrical contacts and treated so as to render said curable thermosetting underfill composition non-flowable. said curable thermosetting underfill composition being distinct from said fluxing agent,

[2] Claim 1 is reproduced from the amendment of July 28, 2003.

wherein upon mating said chip die with said carrier substrate to form a mated assembly and upon heating said mated assembly to a temperature sufficient to render said electrical contacts flowable, said electrical contacts flow to provide electrical interconnection between said chip die and said carrier substrate, and said thermosetting underfill composition cures, thereby adhering said chip die to said canrier substrate.

The examiner relies on the following references:

Gilleo	6,265,776	Jul. 24, 2001 (filed Apr. 27, 1998)
Imasu et al.	6,208,525	Mar. 27, 2001 (filed Mar. 26, 1998)
Wang et al.	6,168,972	Jan. 02, 2001 (filed Dec. 22, 1998)
Torres-Filho et al.	WO 00/56799	Sep. 28, 2000

Claims 1-3, 9-13, 17, 22-24, 49, 50, and 53-56 stand rejected under 35 U.S.C. §102 (e) as anticipated by Gilleo.

Claims 4-8, 14-16, 18-21, 25-48, 51, 52, 60, and 61 stand rejected under 35 U.S.C. §103. As evidence of obviousness, the examiner offers Gilleo, Torres-Filho and Imasu with regard to claims 4-8, 14-16, and 18-21, adding Wang to this combination with regard to claims 25-48, 51, 52, 60, and 61.

A rejection of claim 18 under 35 U.S.C. §112, second paragraph, was withdrawn by the examiner, at page 4 of the answer, and is not before us.

Further, a rejection of claim 57 under 35 U.S.C. §103, as unpatentable over Gilleo, Torres-Filho, Imasu, and Wang, has effectively been withdrawn by the examiner, at page 6 of the answer, since the examiner has now indicated that "claim 57 is allowable over the prior art in independent form..." Presumably, then, the rejection of claims 58 and 59, both dependent on claim 57, has also been withdrawn. Accordingly, claims 57-59 are also not before us on this appeal.

Reference is made to the briefs and answer for the respective positions of appellants and the examiner.

OPINION

With regard to Gilleo and independent claims 1, 49, and 54, it is clear that Gilleo discloses the claimed chip die 12, having electrical contacts 14, wherein the contacts 14 are flowable upon heating; the claimed fluxing agent 16 on the surface of contact 14 (see Figure 3 of Gilleo); and the claimed function of mating the chip die with a carrier substrate to form a mated assembly, with the electrical contacts 14 flowing to provide electrical connection between the chip die and the carrier substrate.

What is in dispute is whether Gilleo discloses the claimed "curable thermosetting underfill composition."

The examiner points to element 18 in Gilleo as the claimed "curable thermosetting underfill composition."

Appellants argue that Gilleo requires the underfill to be a thermoplastic, rather than a thermosetting, material, and that these materials are quite different in that a thermoplastic material is something that softens under heat, but is adequately rigid under normal conditions, although it is capable of deformation under heat and pressure, whereas a thermosetting material is one that will or has undergone a chemical reaction by the action of heat, catalysts, ultraviolet light, etc. leading to a relatively infusible state (principal brief-page 8). Appellants assert further that Gilleo actually teaches away from the use of thermosetting materials as an underfill by his criticism of such materials at column 6, lines 15-20.

As we view the disclosure of Gilleo, especially at column 6, lines 15-20, Gilleo is not teaching away from the use of thermosetting materials for use as underfill. Rather, Gilleo is merely suggesting that where re-working is desirable, as in situations where a chip mounting step has failed to properly position the chip on the board, thermoset assemblies do not allow the assembly to be reworked since thermosets cannot be melted once they have crosslinked. But this, taken together with Gilleo's explicit teaching of using a thermoset material as an underfill (note column 4, lines 30-33: "The

underfill material is preferably a thermoplastic or a thermoset having a very low crosslink density") , makes it clear that Gilleo envisions a thermosetting underfill composition. It is also clear that this thermosetting underfill composition is separate and distinct from the fluxing agent 16 in Gilleo.

Appellants also argue that Gilleo does not disclose thermosets as a useful underfill material apart from their use in combination with thermoplastic materials (principal brief-page 8). We disagree. Clearly, in the passage cited supra, viz., column 4, lines 30-33, Gilleo mentions thermosetting materials and thermoplastic materials as alternatives, and does not require a thermosetting material to always be in combination with a thermoplastic material. Moreover, we note, with approval, the examiner's observation, at page 4 of the answer, that the instant claims do not require the thermosetting material to be the only material in the underfill. In fact, the instant claims call for a thermosetting underfill composition, which leaves open the possibility that the thermosetting material is in combination with other materials to form the composition.

Thus, the only issue left to be resolved is whether Gilleo discloses the thermosetting underfill composition to be "curable," as claimed. Appellants argue that a "curable" material, by definition, requires a change in physical properties through a chemical reaction, with complete reaction resulting in the material being infusible and chemically inert, citing the Concise Chemical and Technical Dictionary (page 9 of the principal brief).

Appellants' position is that:

> Gilleo fails to disclose curable materials, and instead merely teaches thermoplastic materials which do not involve any such chemical reaction under heat to become infusible and chemically inert. In fact, the overall purpose of Gilleo is to provide a material which can melt during heating so that thereafter it may bond properly with a substrate. Such melting is a property of a thermoplastic material. Curable thermosetting materials, on the other hand, harden or cure under heat (principal brief-page 9).

We disagree.

We have established that Gilleo does, indeed, teach the use of thermosetting materials as the underfill. Column 3, lines 30-35, of Gilleo recites that a sufficiently high temperature is applied to melt the underfill material (which may be a thermosetting material) and that the assembly is then "allowed to cool to a temperature which allows the solder and underfill material to solidify." Column 4, line 29, of the reference states that a layer of "hardenable underfill" is used and that underfill material may be a "thermoset" material. All of this sounds like a "curing" process, within the meaning given to "curable" by appellants. Moreover, where the underfill material in Gilleo is a thermoset, as Gilleo discloses it may be, appellants have shown no difference between the instant claimed invention and that disclosed by Gilleo. If appellants' thermosetting underfill is heated and then cooled, and this is referred to as "curable," we find no distinction between this and Gilleo, when Gilleo's thermosetting underfill is heated and then cooled. The reference appears to us to teach a "curable" thermosetting underfill

composition, just as much as the instant claimed invention and appellants have not convinced us of any distinction therebetween.

Accordingly, we will sustain the rejection of claims 1-3, 9-13, 17, 22-24, 49, 50, and 53-56 under 35 U.S.C. §102 (e) as anticipated by Gilleo since dependent claims 2, 3, 9-13, 17, 22-24, 50, 53, 55, and 56 fall with the claims from which they depend, in accordance with appellants' grouping of the claims at pages 4-5 of the principal brief.

With regard to the rejection of dependent claims 4-8, 14-16, and 18-21 under 35 U.S.C. §103, , from page 9 through page 12 of the principal reference, appellants repeat the argument that Gilleo fails to disclose a thermosetting underfill, as claimed. For the reasons supra, we find this argument to be unpersuasive.

At page 12 of the principal answer, appellants argue the claimed limitation of a thermosetting underfill composition comprising "a curable component made of epoxy resin (i.e., a bisphenol-F-type epoxy resin), a curing agent made of amine compounds for promoting cure of the curable component, and optionally, an inorganic filler component made of reinforcing silicas" (principal brief-page 12). Appellants do not deny that Torres-Filho discloses the claimed thermosetting underfill composition with a curing agent and a filler. Rather, appellants repeat the argument that Gilleo teaches away from the use of a thermosetting underfill composition, so there would have been no motivation to consider any thermosetting underfills. Again, for the reasons supra, we disagree.

With regard to claims 14-16, the examiner relies on Imasu, for its teaching of semiconductor chips made of silicon, in combination with Gilleo and Torres-Filho. Appellants' sole argument against the combination is that Gilleo fails to disclose a circuit chip involving curable thermosetting underfill materials disposed on the chip. Once again, for the reasons supra, we find that Gilleo does, indeed, disclose such thermosetting underfill materials and we will sustain the rejection of claims 4-8, 14-16, and 18-21 under 35 U.S.C. §103.

Finally, we turn to the rejection of claims 25-48, 51, 52, and 57-61 under 35 U.S.C. §103.

The examiner brings Wang to the combination of the other three references for a showing of a second thermosetting underfill composition dispensed in a flowable form over the first thermosetting underfill composition about the electrical contacts and treated so as to render the second curable thermosetting underfill composition non-flowable, wherein the second thermosetting underfill composition is distinct from the first thermosetting underfill composition and the fluxing agent.

Appellants argue that Wang does not involve dispensing a second thermosetting underfill composition on a first thermosetting underfill composition, let alone treating such compositions to render them non-flowable on the chip surface. Instead, argue appellants, Wang discloses providing separate underfill compositions on separate members, namely on chip 200 and on substrate 300, followed by alignment and reflow

to attach the chip and the substrate together through the underfill materials.

Appellants' argument was apparently convincing to the examiner anent claim 57 directed to the method of dispensing the second thermosetting underfill composition on the first thermosetting underfill composition, as the examiner withdrew this rejection (answer-page 6) in response to the argument.

However, with regard to independent claim 25, as the examiner points out (answer-page 6), since Wang discloses the final product of claim 25, and the dispensing step is not recited in that claim, the examiner still finds the subject matter of this claim to be unpatentable in view of the applied combination of references.

We agree with appellants. Wang, in Figure 8B, clearly shows the structure comprising the two thermosetting underfill compositions 210 and 310. However, Wang fails to teach a chip die, i.e., the unattached chip portion, with both the first and second underfill compositions thereon. Instead, the second thermosetting composition is applied to a separate substrate, and not over the first thermosetting composition on the chip die. It is true that once the structure is completed, e.g., Figure 8B of Wang, material 210 is over material 310, but they were not over each other on a separate die prior to assembly. The preamble of independent claim 25 is directed to an integrated circuit chip that is interconnectable with a carrier substrate, and the integrated circuit chip, itself, comprises the chip die, the fluxing agent, and the first and second thermosetting underfill compositions. In accordance with the terms of independent

claim 25, it is only after the integrated circuit chip, having the two thermosetting underfill compositions, is constructed, that the chip die is mated to the substrate carrier to form the mated assembly. While we understand that claim 25 is directed to structure, and not to a method, the claimed structure still requires that the integrated circuit chip have both the first and second thermosetting underfill compositions. Wang does not provide the necessary teaching to make the instant claimed subject matter obvious, within the meaning of 35 U.S.C. § 103, because Wang does not ever show a separate integrated circuit chip having both first and second thermosetting underfill compositions, as required by claim 25.

Accordingly, we will not sustain the rejection of claims 25-48 under 35 U.S.C. §103.

We will, however, sustain the rejection of claims 51 and 52, dependent on independent clam 49, under 35 U.S.C. §103, because these claims recite the entire assembly, wherein a second thermoset underfill compound distinct from the first thermoset underfill compound is "between said chip die and said carrier substrate." The completed structure, shown in Figure 8B of Wang, clearly shows this claimed structure, albeit the structure was not formed by the same method of appellants' invention.

We turn, now, to the rejection of independent claim 60, and claim 61 dependent thereon, under 35 U.S.C. §103.

Claim 60 is directed to an integrated circuit "assembly" having both the carrier substrate and the chip die. The chip die and the substrate are adhered one to the other through a cured thermoset and the cured thermoset comprises first and second dielectric layers.

The claim also recites "...curable thermosetting compositions provided directly on said chip die about said solder from which said dielectric layers are formed." We interpret this latter recitation as a process step within a product claim and, as such, may be ignored because determination of patentability is based on the product itself and not on the process of making that product, In re Thorpe, 777 F.2d 695, 227 USPQ 964 (Fed. Cir. 1985).

As to the product itself, clearly, the structure shown in Figure 8B of Wang depicts an integrated circuit assembly having both a carrier substrate and a chip die, wherein the chip die and the substrate are adhered to one another through a thermoset comprising two dielectric layers 210 and 310.

Thus, we will sustain the rejection of claims 60 and 61 under 35 U.S.C. §103.

We have sustained the rejection of claims 1-3, 9-13, 17, 22-24, 49, 50, and 53-56 under 35 U.S.C. §102 (e). We have also sustained the rejection of claims 4-8, 14-16, 18-21, 51, 52, 60, and 61 under 35 U.S.C. §103. We have not sustained the rejection of claims 25-48 under 35 U.S.C. §103.

Accordingly, the examiner's decision is affirmed-in-part.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 CFR § 1.136(a) (1) (iv).

AFFIRMED-IN-PART

ERROL A. KRASS)
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